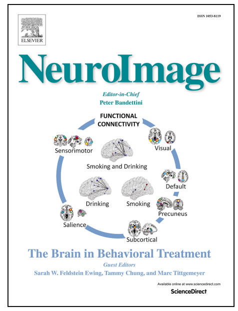

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Mutual Connectivity Analysis of Resting-State Functional MRI Data with Local Models

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Abstract

Functional connectivity analysis of functional MRI (fMRI) can represent brain networks and reveal insights into interactions amongst different brain regions. However, most connectivity analysis approaches adopted in practice are linear and non-directional. In this paper, we demonstrate the advantage of a data-driven, directed connectivity analysis approach called Mutual Connectivity Analysis using Local Models (MCA-LM) that approximates connectivity by modeling nonlinear dependencies of signal interaction, over more conventionally used approaches, such as Pearson's and partial correlation, Patel's conditional dependence measures, etcetera. We demonstrate on realistic simulations of fMRI data that, at long sampling intervals, i.e. high repetition time (TR) of fMRI signals, MCA-LM performs better than or comparable to correlation-based methods and Patel's measures. However, at fast image acquisition rates corresponding to low TR, MCA-LM significantly outperforms these methods. This insight is particularly useful in the light of recent advances in fast fMRI acquisition techniques. Methods that can capture the complex dynamics of brain activity, such as MCA-LM, should be adopted to extract as much information as possible from the improved representation. Furthermore, MCA-LM works very well for simulations generated at weak neuronal interaction strengths, and simulations modeling inhibitory and excitatory connections as it disentangles the two opposing effects between pairs of regions/voxels. Additionally, we demonstrate that MCA-LM is capable of capturing meaningful directed connectivity on experimental fMRI data.

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